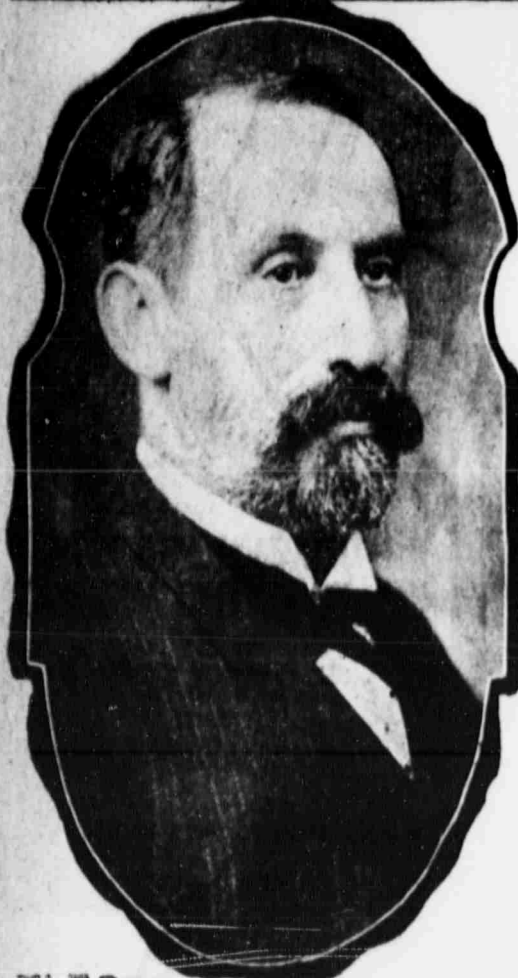


HOW the SUBWAY RUNS from the BATTERY to the B



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Tremendous Problems that Were Encountered and Had to Be Solved.

In the work of construction the subway contractors were confronted by a series of engineering problems that could not be worked out on a basis of precedent. The undertaking was different from anything else of the character that had ever been done. The question of building a tunnel under the most crowded streets in the world, skirting the foundation walls of the tallest buildings in the world, and all without disturbing the most complicated system of sewers, conduits, pipes and ducts, was one that had to be solved along entirely original lines.

Before the subway could be started arrangements had to be made for moving the sewers and conduit systems without disturbing the service for which these utilities were designed. There could be no interference with the water, gas, electric and telephone systems.

Reconstructed Sewers.

The sewers presented the greatest difficulty. For nearly half the entire distance of the subway it is close to the surface of the street. The sewers are at such depth as to interfere with a tunnel constructed close to the surface, so the sewers had to be reconstructed along half the subway route. This meant that sewers would have to be rebuilt off as well as changed and sewers that emptied into one river would have to be shifted to empty into another. In all 12.34 miles of sewer were reconstructed. 7.21 miles along the subway route and 5.13 miles remote from it.

The biggest job was encountered at Canal street, where the flow of the sewer was carried into the East River instead of the Hudson River, permitting the sewer to be bulkheaded on the west side and continued in use. A new sewer was constructed on the east side, running away from the route of the

subway for more than a mile.

It was found necessary to build a 6½ foot circular brick conduit under Chatham Square. The street surface there could not be disturbed, owing to the network of wires, the conjunction of street-car lines, the L. road pillars and the enormous vehicular traffic.

Tunnelled Through Sand.

The engineers determined to build the sewer by tunnelling. The material to be tunnelled through was very fine sand, and a new method of boring had to be devised. It was a modification of the shield system used in tunnelling under rivers, and the laboriousness of it may be imagined from the fact that the maximum rate of work allowed the completion of but twelve feet per week.

A six and a half foot circular brick sewer was encountered at the subway level at One Hundred and Tenth street and Lenox avenue. Part of it was removed and three 42-inch cast-iron pipes, running under the subway, were substituted. At One Hundred and Forty-ninth street and Railroad avenue, to get a sewer under the subway, it became necessary to run it under tide level. This called for permanent siphons, and two were built. This was the only instance where siphons were used.

In many places gigantic water and gas pipes were encountered that could not be moved to spaces under or over the subway or parallel with it. Instead of these big pipes many small ones were substituted and laid along the tunnel roof. When they were ready the water or gas was turned into them through connections with the main pipes, and the superfluous pipes were removed.

Trouble With Surface Lines.

The street railway lines gave endless trouble throughout the work of construction. The common way of handling them where they could be removed to the sides of the street was to undermine them with tunnels extending from the curb to the middle of the street, place a concrete bed in these cross tunnels and build upon the concrete beds vertical trestles. These supported the tracks. Then the ground was excavated between the trestles.

One of the most interesting pieces of construction work along a plan not followed elsewhere was done with the five-track section in Forty-second street between Park avenue and Broadway. The excavation here was about thirty-five feet deep, and extended from ten to fifteen feet into rock.

Careful work was necessary wherever the "L" road was encountered. At Forty-second street and Sixth avenue, as hundreds of thousands of New Yorkers remember to their sorrow, the four stairways of the station were directly over the subway excavation. Each of these stairways had to be braced. Foundations were made for them by digging narrow pits, placing in them a bed of concrete and building up a solid wooden foundation to which the "L" pillars were riveted.

One of the hardest sections of the subway was in Park avenue between Thirty-fourth and Forty-first streets. It was here that shifting rock was found, which slid until the houses on the east side of the street were in danger of collapse. It was here that Major Ira A. Shaler, the most unfortunate of the subway contractors, was killed just as he had

brought his work to a successful conclusion in the face of difficulties next to insurmountable. The subway here is divided into two circular iron tunnels, and passengers on the trains will have an opportunity of judging of the difficulties encountered by the dauntless men who bored through so far underground.

Fear was expressed when it was made known that the subway was to run through Columbus Circle that the Columbus monument would be undermined in such a way that it would fall. On the contrary, the Columbus monument was not disturbed a fraction of an inch, although the subway passes directly under it on the east side, three feet from the centre. Repetitive tunnels were built, outside and under the foundation, filled with concrete and so braced that they held the foundation steady until the subway was completed and braced.

The subway runs directly under the Hotel Belmont, Forty-second street and Park avenue, and under the towering Times Building at Forty-second street and Broadway. The foundations for these buildings—that is, the bed rock on which the supporting columns are placed—is away below the level of the subway bed. The columns do not interfere in any way with the subway tracks or stations, although they are entirely distinct from the subway structure.

The tunnel between One Hundred and Fifty-seventh street and Fort George is the longest two-track tunnel in the world with one exception—the Hoosac tunnel. Only two shafts were sunk. Work was prosecuted both ways from these shafts and from either end. The shafts are now utilized for the elevators to the stations on the tunnel level.

Under the Harlem River.

By far the most interesting section of the tunnel from an engineering standpoint is that under the Harlem River. The bed of the river is so soft that tunnelling of the ordinary kind was impossible and a new method had to be devised. Two separate tunnels of circular form, built of cast iron and steel, were planned. They were built on shore and sunk into concrete beds built in caissons in pile-increased guideways down in the mud of the bottom. The tunnel under the river is dry as a bone.

From start to finish the work was one of difficulty, but these particular instances related above were the ones that presented the most serious obstacles. Not until the people of the city have time to ride through the subway and take careful note of it as they learn to locate themselves will they realize what a big job it has been.

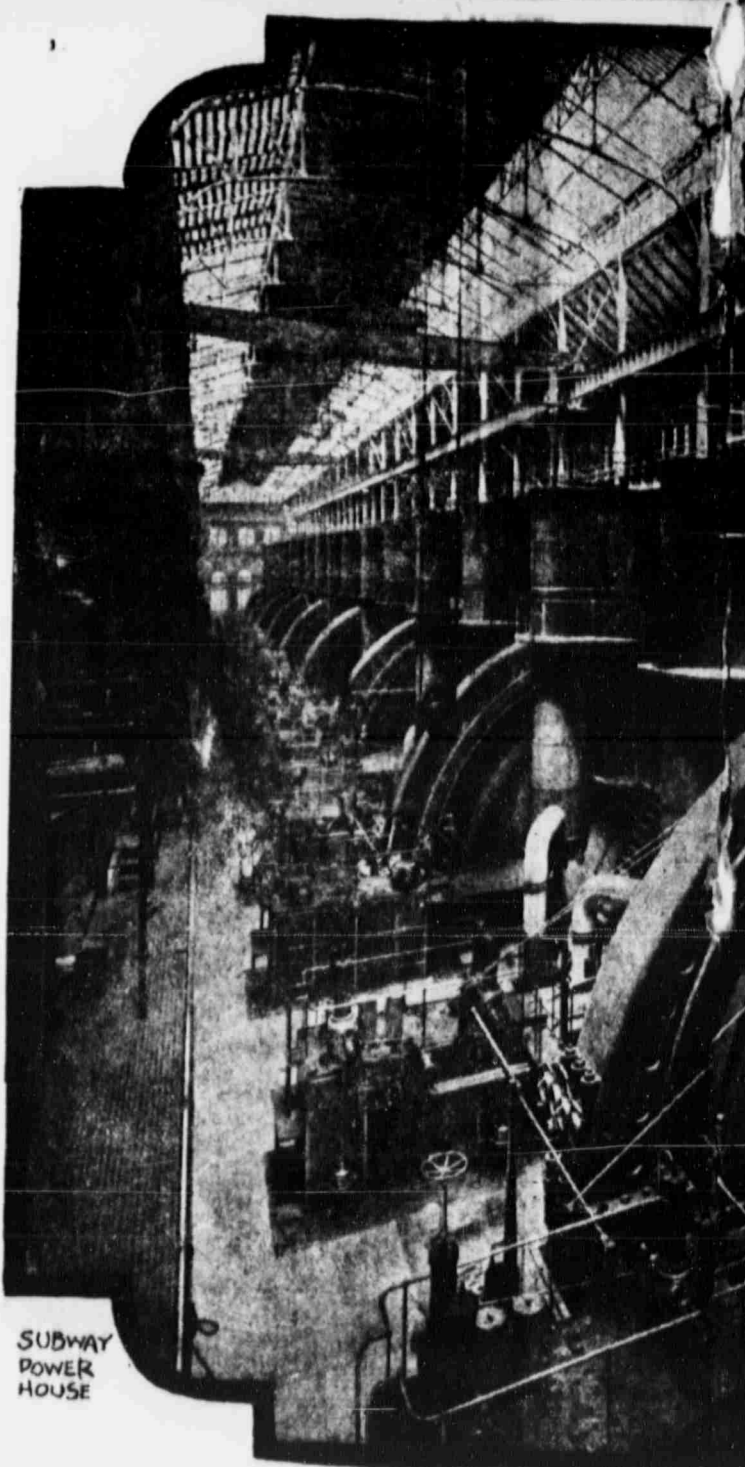
How the Subway Will Set Power for Its Operation.

In addition to the greatest Subway in the world New York will have, as a necessary adjunct, the greatest powerhouse in the world.

The building is between Fifty-eighth and Fifty-ninth streets and Eleventh avenue and the North River. In time it will occupy all the space between the river and the avenue. It will contain 72 boilers and 12 engines each engine directly connected to a 5,000 kilowatt alternator. The plant will develop 100,000 horsepower without the slightest strain on the machinery.

To avoid the danger of a general breakdown of power the boiler-house and generating-room are divided into six sections, each independent of the other. Nothing short of an earthquake could possibly render enough of these sections useless to paralyze the road.

The boilers are fed automatically from gigantic coal bunkers located under the roof of the building. There are seven bunkers in all, with a combined maximum of 18,000 tons.



SUBWAY POWER HOUSE

Enormous Difficulties That Were Overcome in Subway Construction.

FOR THE EVENING WORLD SUBWAY SOUVENIR.

BY S. L. F. DEVO,

Chief Engineer of The Rapid Transit Subway Construction Company.

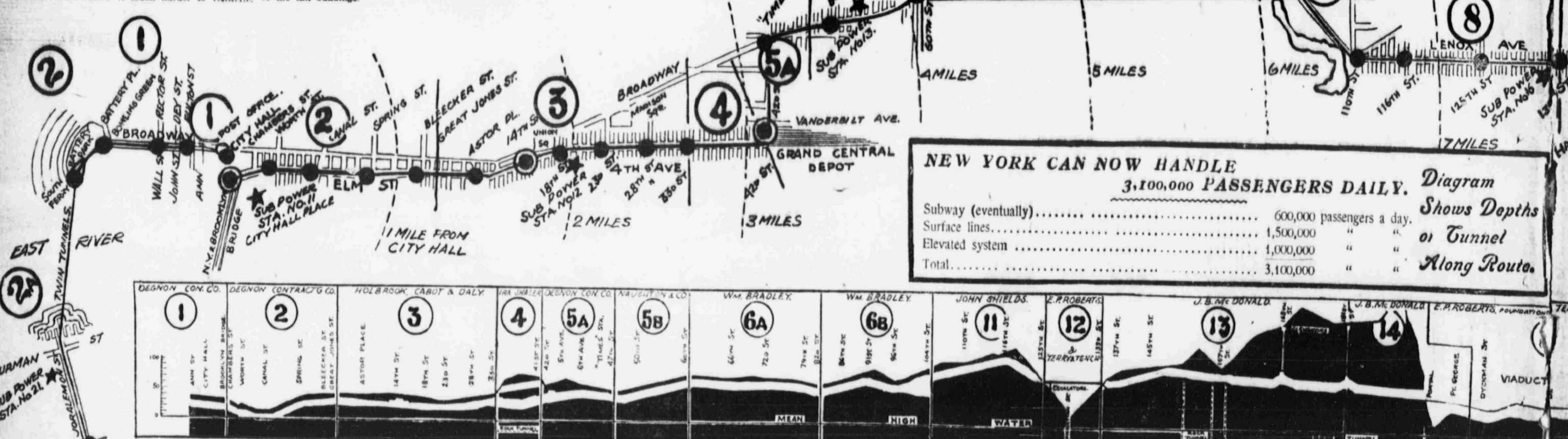
TWO million cubic yards of earth and one million cubic yards of rock have been removed from the subway—enough material to build a pyramid 300 feet high with a base 300 feet square. This is not so great as the amount excavated and carried to sea every year from the new cellars of New York. There is no danger of Manhattan Island either caving in or falling over because of the amount of material removed to make room for the subway.

The cities of the world now provided with subways are London and Budapest, Paris and Glasgow in Europe, and Boston in this country; but the New York subway is the longest. It is the only subway in the world that has four tracks. The London subway is much deeper, requiring the use of elevators at all stations, which makes it much harder to ventilate.

The London tunnel is lighted artificially throughout, while a great portion of our system does not require artificial light.

The building of the New York subway has furnished 6,948,917 days' labor for all classes of workmen, skilled and unskilled. As high as 12,000 men have been employed in a single day. That was in the summer and fall of 1903, when work was in progress all along the line.

There have been more difficulties to the lineal foot on the New York subway than on any other railroad work ever undertaken. These difficulties include the care of and reconstruction of the sewers, the gas and water, mains, private vaults and the surface railroads, together with the underpinning of the tall buildings.



One Hundred Facts About New York's Great Subway.

In 1894 the people of New York voted that the tunnel should be a municipal enterprise to be owned by the city.

After six years of preliminary work the Rapid Transit Commission advertised for bids on Nov. 15, 1899.

John B. McDonald and the Onderdonk Construction Company submitted bids. Mr. McDonald's was accepted on Jan. 15, 1900.

He offered to construct the tunnel for \$5,000,000, with \$2,750,000 additional for terminals, station sites, &c.

The total cost has been close to \$100,000,000.

The money for the construction was loaned by the city. It is to be repaid with interest in fifty years.

The rental for the tunnel is the interest on the bonds and 1 per cent. additional; the latter payment contingent in part upon the earnings of the road in the first ten years.

Contractor's Heavy Security.

The contractor deposited \$1,000,000 in cash for security for construction, a bond with surety for \$1,

and an additional bond of \$1,000,000 to secure performance of contract.

He organized a construction company, of which August Belmont is president. Another company for the operation of the Subway was organized inside this corporation.

The Interborough Rapid Transit Company has the privilege of operating the road for fifty years, with the option of twenty-five years' renewal at a readjusted rate of rental. When the Subway finally passes into the hands of the people the equipment must be bought by the city at a valuation to be determined by arbitration.

Mr. McDonald subcontracted the work of construction to thirteen sub-contractors.

Ground was broken for the Subway on March 25, 1900 in front of the City Hall by Mayor Robert A. Van Wyck.

The contractor pledged himself to have the subway ready for the people in four and one-half years.

The Subway extends from City Hall to Kingsbridge on the west side, and Bronx Park on the east side.

The main line from City Hall to Kingsbridge is 13.59 miles long, with four tracks to Ninety-sixth street.

The east side line from One Hundred and Third street and Broadway to Bronx Park, is 6.97 miles long, making a total mileage of 20.47.

Five miles of the system is on viaducts.

There are 47.11 miles of single track and sidings, equal to one-third of the distance between New York and Albany.

The stops average three a mile for local trains and one every two miles for express trains.

There are 48 stations on the entire system, 33 underground, 11 on viaducts, three partly on the surface and partly underground, and one partly on the surface and partly on the viaduct.

Two of the underground stations are reached by elevators and one of the viaduct stations is reached by escalators.

At present trains run only to One Hundred and Forty-fifth street. The system will be complete through on the east and west sides in three months. The highest grade is one of 3 per cent. on each side of the tunnel under the Harlem River.

At each station there is a downgrade of 21 per cent. to accelerate the trains in starting.

Lives Lost in the Work.

In the work of construction 120 lives were lost, the greatest number at one time in the Park avenue explosion, which wrecked the Murray Hill Hotel.

The actual time spent in construction was 1,275 days.

Gauged by the number of men employed the working days numbered 5,943,917.

The largest number of men employed in construction on any one day was 12,000.

The average number of men employed per day was 4,681.

There were 2,000,000 cubic yards of earth and 1,000,000